the action of the drug. Third—when taken internally, comparatively slow absorption, so that the poison is removed from the blood by the kidneys, etc., as fast as it enters it.

Art. XII.—*The Antagonism of Poisons.* 1. *Antagonism of Morphia and Hydrocyanic Acid.* By John J. Reese, M. D., Professor of Medical Jurisprudence and Toxicology in the University of Pennsylvania.

The subject of the antagonism of poisons, whether real or supposed, is one that has excited more or less interest among both toxicologists and physiologists; nor indeed is it void of interest to the therapeutist, since it may become a question of the utmost moment to him, whether he may venture to combat the dangerous and often rapidly approaching fatal effects of some poisonous substance, by administering an heroic dose of some other equally energetic poison.

Considered in the abstract, there would certainly seem to be no reason why one medicinal or poisonous agent, acting upon the animal economy in some one specific physiological manner, should not be controlled and even neutralized by another agent equally potent, whose *modus operandi* is directly the opposite of the former. Why, for instance, the powerful tetanic, strychnia, which throws the muscles into such fearful spasms through irritation of the spinal marrow, should not be *antagonized* by a substance, the direct effect of which is to relax the muscular system—such as tobacco, bromide of potassium, or Calabar bean. Many other instances will readily occur to the physician, where toxic agents of very opposite physiological character might naturally be supposed to counteract each other's effects, in the animal system.

I do not, however, desire at present to argue this question on its abstract merits. My aim is rather to present the results of a number of carefully conducted experiments, which are, however, by no means yet completed, but which, so far as they go, possess a certain value in throwing light on this vexed question.

My experiments, so far as they have progressed, have reference to the following supposed antagonistic poisons: morphia and atropia, morphia and prussic acid, morphia and strychnia, morphia and aconitia, morphia and arsenic, strychnia and tobacco, strychnia and aconitia, strychnia and tincture of chloride of iron, strychnia and tincture of iodine, strychnia and Calabar bean, and atropia and Calabar bean.

All these several experiments should, in my judgment, be carefully repeated over again, and that more than once, before we would be authorized to deduce any really positive conclusions in reference to this important subject. The medical journals of the day are, as we all well know, full of novel and astonishing cases of just this sort of experimentation, in which a conclusion has been prematurely seized by an over-ardent imagination, and one which, unfortunately, will not stand the test of a critical repetition by other hands.

These present experiments, then, I desire it to be understood, do not claim by any means to be exhaustive; they are rather the beginning of a more elaborate series, which I hope to be able soon to prosecute. In the mean time, however, I have thought that, imperfect as they are as to their number and detail, the profession might feel some interest in perusing them.

The first of these experiments that I shall now notice are those which refer to the antagonism of *morphia and prussic acid.* But in order to get a perfectly clear idea of this real or supposed antagonism, it will be necessary, first, to understand precisely what are the symptoms produced by each one of these poisons when taken separately. Then we shall be the better qualified to appreciate the effects resulting from their combination. I therefore select from my notes first, a few experiments which exhibit the effects of *prussic acid* when taken alone, and then some illustrations of the effects of *morphia* when given alone; after which, the results of administering the two poisons in combination will be detailed.

Expt. 1. *Prussic Acid alone.*—One fluidrachm of the ordinary prussic acid of the shops (2 per cent.) was put into the throat of a moderate-sized dog. In half a minute, the respiration became panting. In 1 minute, he fell over in convulsions; pupils dilated. In 3 minutes, there was retching; in 4 minutes, another slight spasm, with voiding of urine; in 5 minutes, attempts to get up; is unable to stand at the end of 8 minutes, but otherwise appears unaffected.

In 10 minutes after giving the first dose, a similar quantity was administered by the mouth. In half a minute, the respiration became rapid and noisy; in three-quarters of a minute, he fell over in a slight convulsion, uttering a faint cry. In 3 minutes, he lies perfectly quiet; pupils somewhat dilated; eyes apparently insensible. In 12 minutes, appears to be gradually dying; no convulsions. In 16 minutes seems more animated; eyes glazed. In 22 minutes, death takes place almost imperceptibly.

Remarks.—In this case, two fluidrachms of ordinary prussic acid, given in two doses, ten minutes apart, proved fatal in 32 minutes from the time the first dose was taken.

Expt. 2.—Thirty minims of ordinary prussic acid were injected hypodermically into a moderate-sized dog. In 7 minutes, no obvious effects were exhibited; the dose was now repeated. In 4 minutes after, slight vomiting took place. In 5 minutes, the gait became unsteady; no cry; appears as if partially narcotized. In 6 minutes cannot stand for any length of time; pupils natural. In 7 minutes, vomiting repeated, and more abundant. In 10 minutes, vomits bile; bladder and rectum evacuated. In 12 minutes, the peculiar spasmodic movement of the jaws, followed by more vomiting of bile; pupils somewhat dilated; seems to struggle against the spasms and gradually lies down. In 14 minutes, tenesmus. In 15 minutes, there is general rigidity, though he maintains the erect position; great tenesmus. In 16 minutes, there is a general rigid spasm, though still on his feet. In 17 minutes, lies down, with his legs doubled under him. In 20 minutes, spasmodic action of the jaws, with retching and vomiting of bile. (Apparently, the force of the poison has been spent upon the alimentary canal.)

In 24 minutes, the dose was repeated (30 minims hypodermically). In 1½ minutes, the peculiar spasms were observed; falls over; but no cry; strives to keep upon his feet. In 3 minutes, he falls, in partial convulsions. In 4 minutes, the spasm is general, but no rigidity. In 8 minutes, violent spasm, which does not continue. In 9 minutes, slight rigidity. In 10 minutes, convulsions of fore legs; lies on his back. In 12 minutes, violent convulsions; kicking of the legs. In 30 minutes, the respiration decreasing in frequency, gasping; apparently dying. In 33 minutes, seems better; respiration more frequent and less laboured.

He was left in this condition; and the next morning, he was so well recovered as to be able to walk about, although evidently weakened.

Remarks.—In this case, one and a half fluidrachm was given, in three separate doses, all within 24 minutes, from the effects of which the animal barely recovered.

Expt. 3.—A small terrier bitch took about 25 minims of ordinary prussic acid, by the mouth. In half a minute, she reeled over in convulsions, uttering a slight yell. In 1 minute, respiration was very laboured, 60 per minute; pupils moderately dilated. In 4 minutes, slight rigidity. In 6 minutes, respiration was 32, gasping; lies perfectly quiet; pupils less dilated; slight rigidity in the fore legs. In 10 minutes, respiration was 30, very laborious; bowels evacuated; complete relaxation; pupils rather more dilated. In 15 minutes, respiration 24, more laboured. In 20 minutes, respiration 25; pupils less dilated; relaxation of muscles complete. In 25 minutes, respiration 40, stertorous; pupils about the same. In 30 minutes, respiration 44. In 33 minutes a transient convulsion. In 1 hour, respiration 40; slight rigidity of fore legs, along with a slight convulsion; after which the *cold affusion* was practised. No apparent benefit resulted at first, violent convulsions occurring 14 minutes subsequently, with very contracted pupils. In 20 minutes, the condition remained much the same; tongue lies flabby in the mouth, purplish underneath; respiration 40; pupils still contracted, though sensible to the light. In 40 minutes, the pupils were natural; respiration 40. The cold affusion was now repeated; the animal rouses under it; shakes herself, and screams out under its repetition. In 50 minutes, consciousness is evidently returning; the animal arouses and turns herself over. In 1 hour, the affusion was again repeated; she gets up, attempts to walk, dragging her legs; trembling of whole body; respiration 40, less laboured. In this condition she was left lying on her side. In two or three hours, she completely revived, appearing on the next morning, as bright as ever.

Remarks.—In this case, a comparatively small dose of prussic acid (25 minims) produced alarming effects, which appeared to be modified, if not counteracted, by the cold affusion, repeated.

Expt. 4. *Morphia alone.*—One-third of a grain of morphia in solution, was injected, hypodermically, into a young dog. In 1 minute, the pupils were much dilated. In 3 minutes, slight vomiting. In 5 minutes, slight moaning. In 7 minutes, some muscular debility; tends to lie down, but gets up again. In 15 minutes, pupils somewhat contracted; bowels evacuated; can walk about easily. In 20 minutes, appears drowsy, but very sensitive to the flies, etc. In 28 minutes, a similar dose was administered hypodermically; followed in half a minute, by whining. In 1 minute, there was general relaxation of the limbs, with a tendency to lie down. In 15 minutes, pupils contracted; lies down, but is easily aroused. In 20 minutes afterwards, he took another one-third of a grain by the mouth. In 3 minutes, there was dilatation of the pupils, with marked drowsiness. In 4 minutes, the eyes were closed. In 6 minutes, pupils contracted, but sensible to light. In 10 minutes, seems fully asleep, but can be aroused. In 20 minutes, sleep more profound; breathing tranquil; can yet be partially aroused; coma never perfect. In 50 minutes, he has partially aroused; can walk about. He was left in this state, lying tranquilly on his side. In about three or four hours, he was completely recovered.

Remarks.—In this case, one grain of morphia was given to a very young dog, in three separate doses, all within forty minutes. The narcotic symptoms were all well pronounced, though the animal recovered in about four or five hours. In this, as well as in all my other experiments with morphia on dogs, the immediate effect was invariably to dilate the pupil; though the subsequent contraction was always well marked.

Expt. 5. *Prussic Acid and Morphia.*—Half a grain of sulph. morphia dissolved in water was injected hypodermically into a full-sized Scotch terrier dog, after a prolonged fast. In 4 minutes, he vomited mucus; some loss of muscular power; pupils rather dilated. In 11 minutes, the dose was repeated; followed by increased feebleness; pupils slightly contracted. In 17 minutes, 30 minims of the ordinary prussic acid were given by the mouth. In 2 minutes afterwards, he lies down; no cry, nor convulsion; pupils somewhat contracted; sensation perfect. In 13 minutes, fell over, and became comatose. In 45 minutes from the commencement of the experiment, he lay perfectly quiet; respiration 24; eyes very sensitive. In 1 hour, coma; respiration 19; difficult to arouse. In 1 hour 20 minutes, respiration 22; still very quiet. In 1 hour and 35 minutes, could be aroused; walked with a tottering gait. In 3 hours, he had comparatively recovered; responds to call; pupils natural.

At this time, administered half a grain of morphia and 15 minims of prussic acid combined, by the mouth. In half a minute, there was very rapid breathing; no cry nor convulsions. In 3 minutes, breathing very rapid and gasping; slight twitches of abdominal muscles. In 15 minutes, no visible effects except great debility; but he can yet partially rise upon his feet. Now, repeated the last dose, by the mouth. In half a minute, very rapid breathing. In 1 minute, fell over, in moderate convulsions; breathing rapid and stertorous. In 5 minutes, no yell; lies quiet; pupils moderately dilated. In 6 minutes, slight twitchings; rigidity increasing; pupils contracting. In 10 minutes, no rigidity; respiration very laboured. In 15 minutes perfectly quiet; coma; pupils contracted; respiration 18, labouring. He was left in this state, and at the end of 5 hours after the first experiment, he was so far recovered as to be able to run about the lot, from which he made his escape during the night.

Remarks.—In this case, a strong, full-grown dog took two grains of morphia, and one fluidrachm of ordinary prussic acid, in three divided doses, at intervals; from which he ultimately recovered. The symptoms observed and recorded evince a decided preponderance of the effects of the morphia over those of the prussic acid; which latter, however, was in a minimum quantity. In the succeeding experiment, these two poisons were given in more equal doses, and with a different result.

Expt. 6.—To a full-grown dog, though under average size, half a grain of morphia and thirty minims of ordinary prussic acid were given together by the mouth. In 1 minute, the gait was tottering. In 2 minutes, pupils much dilated; no cry; walks around as if dizzy. In 4½ minutes, vomits; loss of muscular power; sits down; no convulsion. In 15 minutes, repeated the same dose. In half a minute, the characteristic yell. In 1 minute convulsion, with very rapid and laborious breathing. In 2 minutes, used the cold affusion; pupils much dilated; respiration 56, stertorous. In 5 minutes, a strong convulsion; pupils less dilated. In 15 minutes, can stand erect; pupils still slightly dilated.

Now, again repeated the same dose. In half a minute, fell over; respiration very rapid. In 1 minute, convulsion; no cry; pupils strongly dilated. In 1½ minute, a rigid spasm, followed by stertorous breathing. In 3 minutes, relaxation and less dilatation of pupils. In 4 minutes, respiration 36. In 10 minutes, only slight rigidity. In 30 minutes, no more convulsions; lies quiet, with stertorous breathing; pupils natural.

In 50 minutes after taking the third dose, it was again repeated—making in all two grains of morphia, and two fluidrachms of prussic acid given in the course of 1 hour and 20 minutes. In half a minute, the cry, and a violent spasm. In 2 minutes, the rigidity ceased; breathing very laboured and stertorous, only 12 per minute; pupils natural; complete coma and insensibility; respiration gradually became slower. In half an hour, respiration only 5 per minute; shortly after which death took place, in a convulsion.

Remarks.—This case would seem to show that, when morphia and prussic acid are given, each in a full dose, the symptoms of *both* toxic agents are clearly manifested. And further, that morphia does not counteract the fatal effects of prussic acid, unless it be in large excess over the latter—if it does so even then, but not if the latter be taken in a full poisonous dose. It may also be remarked that the cold affusion, which was only once employed in this case, appeared to be of no avail in counteracting the effects of the prussic acid, as in the former case (Expt. 5), possibly, because it was not followed up.

Expt. 7.—In this experiment the same quantity of morphia and prussic acid was administered as in the last-mentioned case (Expt. 6), viz., two grains of morphia, and two fluidrachms of prussic acid; and with the same fatal result.

One grain of sulphate of morphia was injected hypodermically into a large dog. In 3 minutes, there was slight dilatation of pupils. In 6 minutes, cries out. In 15 minutes, gave half a grain additional hypodermically. In 20 minutes, appears drowsy; lies down; pupils not yet contracted. In 30 minutes, slight contraction of pupils; sensibility perfect.

Now, gave by the mouth half a grain of morphia, with one fluidrachm of prussic acid; (the object having been to induce the influence of the slower poison before giving the more rapid one.) In 1 minute, no visible effect, except that the previous influence of the morphia was very apparent. In 2 minutes, relaxation perfect. In 3½ minutes, cries out; slight twitching of the fore legs. In 5 minutes, moans; pupils slightly dilated; breathing very rapid. In 6 minutes, apparent loss of sensibility. In 8 minutes, perfect relaxation; no convulsive action. In 9½ minutes, twitching of limbs. In 13 minutes, the eyes closed; pupils slightly dilated.

In 15 minutes, gave one fluidrachm of prussic acid, by the mouth. In half a minute, respiration becomes much slower. In three-fourths of a minute, groans and cries out. In 1 minute, bowels evacuated. In 1½ minute, a rigid convulsion, with great dilatation of pupil. In 2 minutes, relaxation; respiration rapid. In 3 minutes, convulsion, followed shortly by relaxation. In 4½ minutes, a slight spasm; rigidity of fore-legs. In 5 minutes, pupils dilated. In 6 minutes, spasm without rigidity. In 7 minutes, pupils contracting; spasm repeated. In 11 minutes, rigid convulsion; pupils more dilated. In 13 minutes, another spasm; respiration 46, stertorous. In 15 minutes, another spasm, which was repeated in 18 minutes.

In 1 hour, he lies quiet, in a deep sleep. In 1 hour and 10 minutes, a strong convulsion; no rigidity; eye natural. In 1 hour and 35 minutes, a severe convulsion, followed in 10 minutes by another one. In two hours, rigidity of the fore-legs; breathing stertorous; another severe spasm. In 2 hours and 20 minutes, a moderate convulsion. In 2 hours and 30 minutes, opisthotonos; respiration slow and gasping, soon ending in death.

Remarks.—In this case, as in the preceding one, the combined effects of the double poison were sufficiently well marked. The *fatal* result, in both cases, is undoubtedly attributable to the prussic acid, rather than to the morphia.

The following experiment, in which the two poisons were used in rather smaller doses, though in about the same relative quantities, will illustrate how *nearly* fatal the results may be, without proving absolutely so. Here, the more active poison was the one first administered.

Expt. 8.—To a moderate-sized dog, full-grown, 30 minims of ordinary prussic acid were given by the mouth. In 1 minute, he fell over in convulsions. Almost immediately the cold affusion was applied to his head and chest. In 4 minutes, he vomited bile. In 5 minutes, was able to stand. In 8 minutes, the cold affusion was repeated; condition much improved.

In 10 minutes, he received half a grain of sulphate of morphia by subcutaneous injection, which produced moaning in 4 minutes, but no convulsions; pupils much dilated; is able to stand up. In 16 minutes, respiration 38. In 20 minutes, pupils less dilated; is very drowsy. In 25 minutes, respiration 28, regular; eyes blink; is perfectly quiet and drowsy.

In half an hour from the commencement, gave him fifteen minims, additional, of prussic acid. In 2½ minutes, groaning and restless. In 4 minutes, convulsions; bowels evacuated. Fell over before 5 minutes. In 6 minutes, still groaning; lies quiet; respiration 60; pupils as before. In 7 minutes, groaning repeated; gets up; respiration 36. In 10 minutes, respiration 40; groans on being disturbed.

In 15 minutes, took fifteen minims more of the acid. In half a minute, he began to twitch. In 1 minute, groans. In 3 minutes, slight twitching of the muscles of the face, followed by a general convulsion; pupils dilated. In 30 minutes, respiration 28, very laboured. In 40 minutes, eyes almost natural, and sensitive to light. In 1 hour, respiration 20, very laboured; lies perfectly comatose. A sudden severe spasm now took place, lasting nearly one minute; appears to be dying; pupils greatly dilated. He continued in this state for another hour, when he had a similar convulsion. In 2¼ hours, from the commencement there were occasional groanings; pupils dilated; appears somewhat better; breathing rather less laboured.

In 2 hours and 20 minutes, gave him one-third of a grain of morphia and fifteen minims prussic acid, by the mouth; deglutition very difficult. In 2½ minutes, the characteristic yell. In 3 minutes, slightly convulsed, followed by repose; respiration less laboured; is apparently insensible.

In 15 minutes, repeated the last dose; deglutition very difficult. In 2 minutes, the characteristic yell; prolonged convulsion. In 12 minutes, appears as if dying; the breathing becoming more prolonged and difficult; no convulsions. He was left in this state for dead, but, to my surprise, I found next morning, that he had revived during the night; and he appeared quite well, with the exception of some debility.

Remarks.—In this instance, as in the others, the combination of symptoms is sufficiently evident. The recovery of the animal, after such serious and protracted symptoms, seems remarkable. He took altogether one and a sixth grain of morphia, and one and a half fluidrachm of prussic acid, in divided doses.

All the above experiments are varied, as will be perceived, both as to the absolute and relative doses of the poisons employed, as well as to the mode of employing them. The deduction would seem warrantable, that the antagonism between prussic acid and morphia is very slight, if indeed it exists at all.

This fact assumes an importance by no means trifling, when regarded in a medico-legal point of view. In a recent criminal case which has excited considerable interest in our community—that of Dr. Schœppe—it was strongly alleged by the prosecution that the deceased had died from having taken a combined dose of morphia and prussic acid, although the chemical evidence failed to establish the presence of either of these poisons after death; and the symptoms before death were utterly inconsistent with the existence of at least *one* of the alleged poisons, namely, prussic acid. The testimony most relied on by the prosecution, to sustain this very extraordinary allegation, was that of a physician, who undertook to say that the symptoms of the deceased (which were really only the ordinary symptoms of apoplexy) were such as would result from a combination of morphia and prussic acid, *because*, some thirty years previously, he (the physician) had administered to a chicken-hawk a mixture of corrosive sublimate, opium and prussic acid; and that the bird died the next day, after exhibiting certain symptoms which, in his opinion, resembled those of the deceased!

Medico-legal knowledge must, truly, be at a very low ebb, and its estimate by our courts of justice must be of an exceedingly trifling character, when they can permit so solemn a procedure as that of a trial for murder, to be disgraced by testimony so absurd as that above quoted.

But, inasmuch as murder *may* actually be committed by the administration of two or more poisons combined, under the impression that the usual well-known symptoms of each will be masked, or neutralized by the effects of the other, it becomes a matter of the utmost consequence to legal medicine, in addition to its interest to the toxicologist, the physiologist and the therapeutist, to arrive at some definite and positive conclusion as to the real facts of the case.

In a future communication, I shall offer some observations in reference to the antagonism between *morphia and atropia;* and, also, between *morphia and aconitia*, and between *morphia and strychnia.*

ART. XIII.—*Traumatic Paralysis of the Visual Accommodation.*

By GEO. C. HARLAN, M.D., Surgeon to Wills Ophthalmic Hospital.

A YOUNG man in full health came to the Wills Hospital, complaining of dimness of vision in the left eye. Fifteen hours before, the eye had been struck by a piece of iron chipped from a tool that he was working with. There was no pain, and no external appearance of injury but a slight general injection of the conjunctiva. He complained only of dimness of vision. No application had been made to the eye. The pupil was widely dilated, only a narrow rim of the iris to be seen. The acuteness of vision was very much diminished. At twenty feet, only No. 70 of Snellen's type